Maize for Food, Feed and Fuel in Indonesia: Challenges and Opportunity

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Introduction

Maize is an important staple food in many countries and the productionof maize in the world have been increasing steadily. Maize has a wide variety of usages, ranging from food and feed to industrial products, and more recently, as an alternate fuel. The areaplanted with maize is continuously increasing over the years. During 2009-2010 global maize production was 817 million tons,and in2011-2012, global maize production reached its high of 873 million tones.The variations in productivity are due to many factors, including weather pattern during the crop growth, pests and diseases, technological practices andimproved hybridvarieties planted by growers.

The global supply and demand of maize is influenced mainly by the US, which has the largest harvested area and the highest grain production. China, Brazil, Mexico, Indiaand Indonesiacontribute significantly to the world harvested area. These six countries contributemore than70% of theworld corn production. The global maize demands are influenced by the major usage patternsin the US, namely for edible oil, feed, and for ethanol production. Biofuels derived from maize grain had gainedinterest worldwide, due to the concern over unrenewable fossil source energy. Ethanol accounted for over 6% share in the USenergy consumption in 2000-2001 and rose to over 40% in 2011-2012. On the other hand, the share for feed was declining. The diversion of maize usage from food and feed to ethanol production would then pushed price higher.

In Indonesia, maize is the second most important cerealcrop after rice, and is promising for agriculture diversification, since it is more resilient to climate changes. Food diversification is one of the main targets in Indonesian agricultural policy aimingto reducing high dependency on rice for food. In recent years, maize production had shown a notable growth rate and it has contributed significantly to the national economy.Central Bureau of Statistics reported that during 1990-2000, thearea planted to maize was about 19% of the total areaplanted to food crops. Rice occupied about 61% of thetotal area planted to food crops over the same timeperiod. Another 20% of land was planted to other food crops such as soybeans, mungbean, peanut,cassava, and sweet potato. However, in recent years the area planted to maize has increased to about 32% of the total area planted to food crops. A strong demand and good domestic prices had been acting as the pulling factors for growing maize.

The use of maize in Indonesia is mainly for feed and food, while its usage for biofuel is still prohibitive. Biofuel policy in Indonesia focuses primarily on the use of non food commodity, such as palm oil, cassava, sorghum. As those crops can be grown all year round, the potential capacity for biofuel industry in the tropic is substantial.

Overview of Maize Production System in Indonesia

Domestic Maize Production

Indonesia is the sixth largest maizeproducerin the world, contributing 2% to the global production.Maize is grown almost all year round, during both rainy season and dry season in irrigated land. In a farming system, maize has changed its status from a companion catch crop toa main cash crop.

Maize planted area and its production in Indonesia had indicated significant growth over the last three decades of which Indonesia had emerged from net importer to maize self sufficiency. Duringthe last four decades production of maize had increased five folds, from 3 million ton in 1971, to about 17.6 million ton in 2011 (Figure 1). Maize productivity increased significantly from 1 t/ha in 1971 to 4.6 t/ha in 2011. Many farmers in the main production area produce as high as 8 ton/ha dry grain. In contrast, maize area in the last three decades remained almost stagnant at 2.8 million ha in 1971 to 3.8 million ha in 2011.Diversified uses of maize has prompted higher production in Indonesia. Presently, maize is mainly used for feed industry and the remaining is used for food, starch, etc.

Maize is grown in all provinces in Indonesia.In some provinces, such as East Nusa Tenggara, West Nusa Tenggara, Central Sulawesi, South Sulawesi, Central Java, maize is consumed as a supplementto staple food. Region wise,East Java, Central Java, and Lampung are the leading producers of maize in Indonesia while South Sulawesi, North Sumatera, West Java and Gorontalo are the second important producers (Figure2). Among the major producing provinces, East Java tops the list with its contribution to about 30% to the national maize production. Other main producers are Central Java (16%), Lampung (10%), South Sulawesi (7.5%), North Sumatera (7%), West Java (5%) and Gorontalo (4%). Increased of maize production is mainly due to the wide-spread use of hybrid varieties, combined with high rate of fertilizers, and facilitated by good transportation network.

The percentage of area planted to hybrid seeds increased from 55% in 2010 to around66% in 2012. There are 25 Seed Industries in Indonesia (including government owned companies) that contribute to the increasing uses of maize hybrid seed.

Maize Supply and Demand

Maize trade in Indonesia shows a negative trend since 1999, although the domestic production has increased significantly. Trade deficit is due to the increasing domestic demandfor feed and food industries. Maize supply is distributed unevenly depending on seasonal harvest. Lack of storage facilities and inadequate transportation infrastructure hampered the collection of the grains form

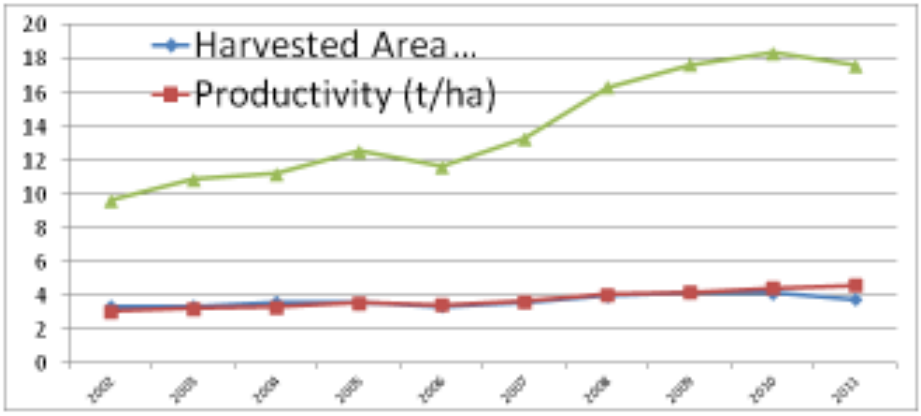

Figure1.Production, harvested area and yield of Maize in Indonesia 2002-2011.

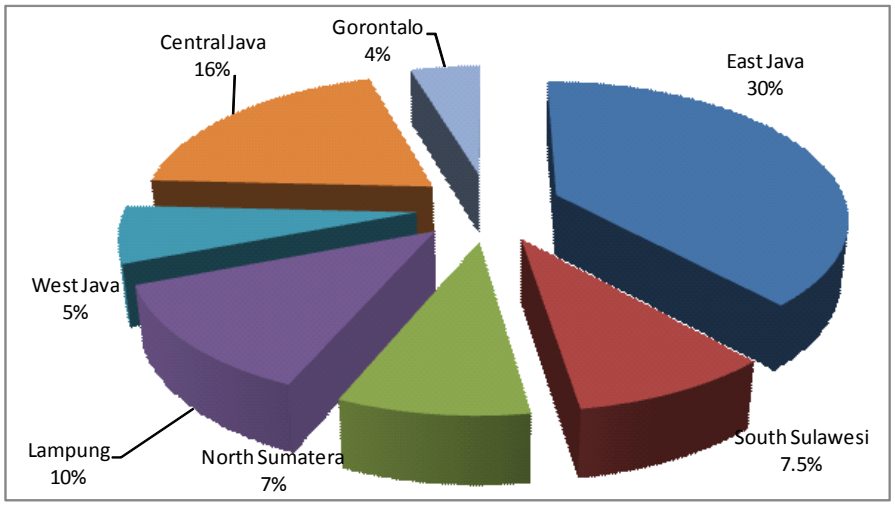

Figure2. Major maize producing provinces

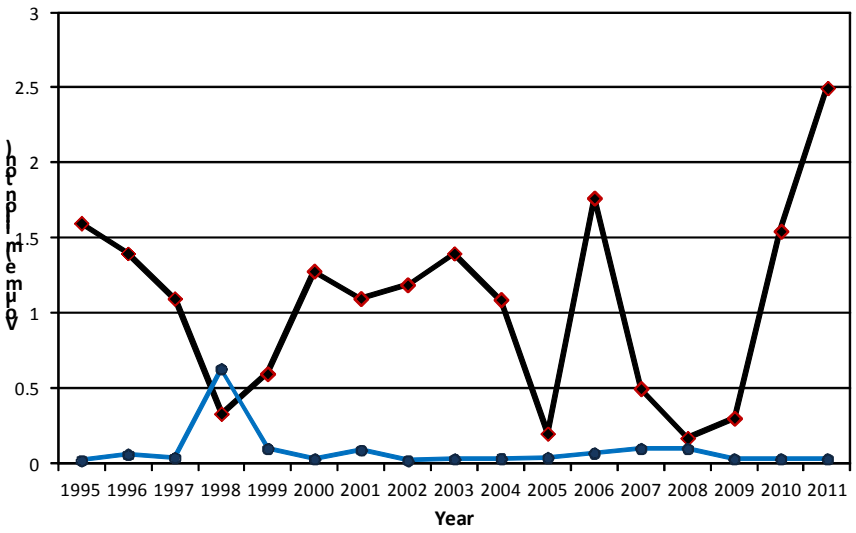

Figure3. Trend of maize export and import during 1995-2011

Table 1.Demands for maize in Indonesia, 2007-2011.

Year	2007	2008	2009	2010	2011
Production (ton)	11,197,776	13,921,249	14,813,155	15,236,407	15,492,170
Feed consumption (ton)	8,892,551	11,435,291	12,276,492	12,604,741	12,929,854
Food consumption (ton)	710,72	527,888	421,09	432,35	445,13
Losses (ton)	1,594,503	1,958,070	2,115,570	2,199,313	2,117,189
Surplus/devisit (ton)	2,464,174	2,457,192	3,072,275	4,606,524	4,706,419

remote area to the end users. When supply is low, import becomethe choice. The amount of maize export and import in Indonesia in 1995-2011 is shown in Figure3.

During the period of 1995 to 2011, import volume fluctuated following the domestic demands. The highest volume of maize import occured in 2006 and 2011, i.e. 1.77 million ton and 2.5 million ton.Domestic demand, for feed industries increased steadily due to the increased of people's incomes that directly boost eggs and poultry consumption. Since 2004, the prices of maize hadincreased, attributed to several factors such as rising energycosts, and fertilizers prices, and also increasing demand for grains for biofuels.In Indonesia seasonal oversupply of maize during the rainy season harvest was a frequentproblem, leading to a fall in maize prices. Export of maize is almost stagnant at lower level, the highest occurred in 1998 amounted of 0.63 million ton or about 5% of the national maize production. The major export destinations are Singapore, Japan and South Korea.

Domestic Consumption Pattern

Maize function status in Indonesia had evolved from an almost of all maize production used for human food, to an almost of all maize use for feed. Maize for food had been replaced by rice, except in particular locations such as in some villages of South Sulawesi, East Nusa Tenggara, East Java.During the last five years, demands formaize had increasedfrom 11.2 million ton to 15.49 million ton, or an increase by 8.8%. This phenomenon is attributable to the increasing demand for feed industries by 10.3%, amounted 8.89 million ton in 2007 to 12.93 million ton in 2011. Due to the seasonal harvest of this crop, supply was low during the off season, where import would be needed.

Table2. Proportion of maize usage.

Usage	1985	1990	1995	1999	2009
Seed (%)	2.4	2.2	2.3	2.5	4.0
Oil exctration (%)	0.2	0.4	1.9	3.0	4.0
Feed mill (%)	5.4	14.7	30.5	43.2	54.0
Flour, etc (%)	9.4	17.9	28.3	36.8	20.0
Fresh cobs and food (%)	82.5	63.2	33.6	10.0	18.0

The proportion of maize usages is shown in Table 2. In 1985, approximately 82.5% of maize production in Indonesia was consumed as human food, particularly in the eastern part of Indonesia, such NTT, NTB, Gorontalo,

Central Sulawesi, Central Java. However, as rice becoming more available to the whole population, the proportion of maize for food was shifted gradually to feed industry. In 1999 maize share for feed industry increased sharply to 43.2% whereas maize for the household consumption dropped to alevel below 10%. Domestic demand particularly for feed increased in recent decades due to the high demand for poultry and eggs, as a result of the increase of the living standard,that indirectly boost chicken-meat and eggs consumption. In 2011feed factories had developed in themajor island especially in Java, Sumatera and Sulawesi numbering more than 60 feed mills. The total feed production in Indonesia in 2011 was 13.5 million ton.

Challenges and Opportunity

Application of System Modeling

The Indonesian Agency for Agricultural Research and Development (IAARD) has been applying dynamic approach through system modeling in order to design the strategies for achieving maize self sufficiency in 2014.The integrated program for selfsuficiency in maize is shown in Figure 4.

Maize production system is interrelated and supported by many components such as seed industry, fertilizer and pesticide industry, mechanization in maize production, pest and disease control, fertilization, water,postharvest, insentive, supply chain, and feed industry. Each component is interrelated to each chains and is to be formulated so that the prediction of the system output is measureable. Input-output diagram of Indonesia maize production system is shown in Figure5.

Maize production system and supply chain systemareaffected by three inputs, one expected output and one unexpected input. The environment inputs affecting maize production and supply chain are unreliable climatepattern,water irrigation,farmlands,environmental stresses, including pest and disease outbreak. The controllable inputs are fertilizer , seed, and pesticide, irrigation, farmers motivation, post harvest handling and distribution channel. Uncontrollable inputsalsoincludes demand fluctuation, market price and maize supply. The expected outputs are targeted increase of production, reliable supplymeeting the demand, efficient maize supply chain and profitable investment. The unexpected outputs includefluctuation of market prices, and unstable international maize demands.

Figure 4. Integrated system of maize self sufficiency program.

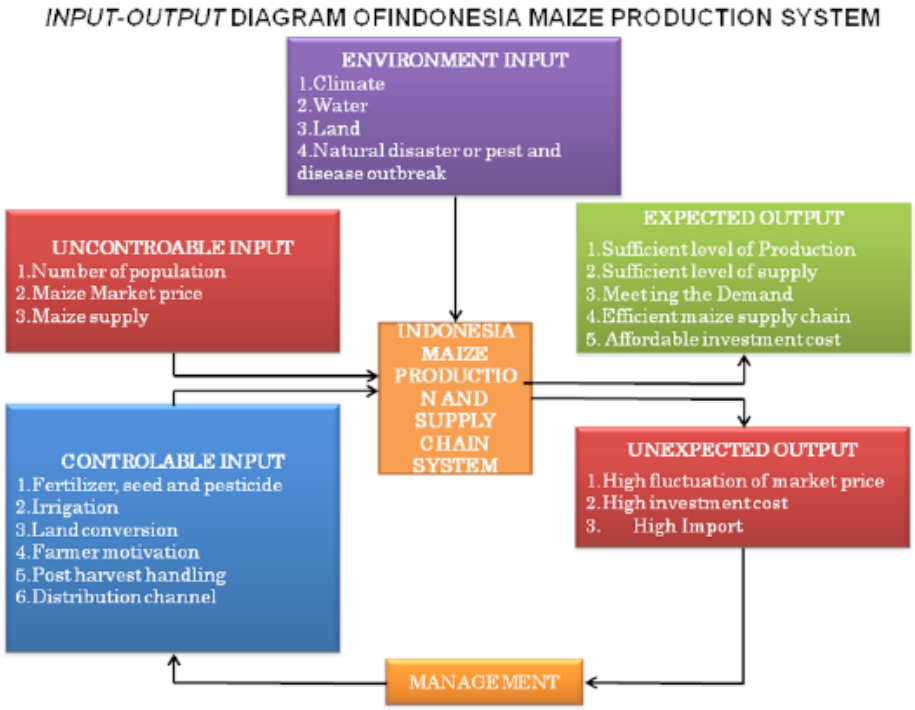

Figure5. Input-output diagram of Indonesia maize production system.

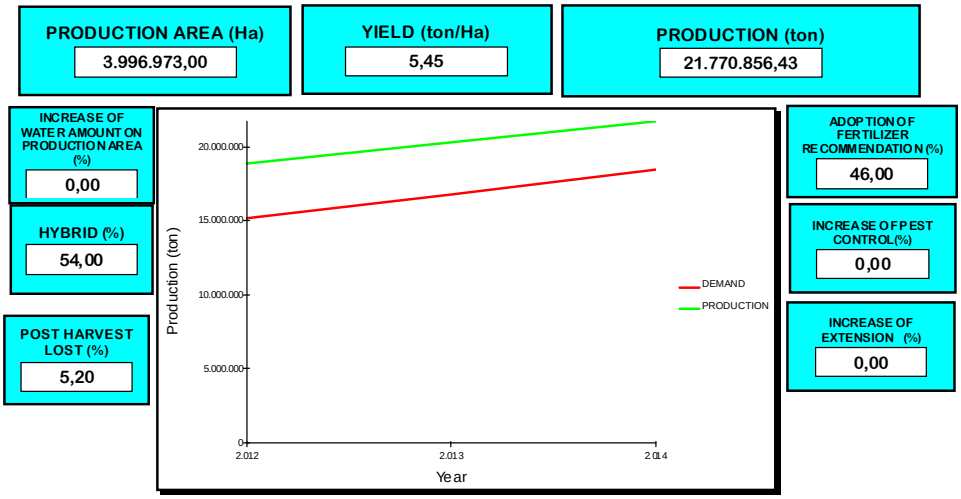

Figure 6. Existing condition of maize production system in Indonesia.

Applying the "Powersim Software" various decision tools could be visualized, including risk analysis and optimization and risk management. The interface of the existing maize production is shown in Figure 6.

The existing production area in Indonesia is approximately 3,996,973 ha with the productivity of 5.45 t/ha. The total production is about 21,770,088 ton. The targeted production is29,000,000 ton in 2014. Water availability, seeds and fertilizer use are among the three mostcritical affecting factors to achieve the targeted production. Based on the simulation model, in order to achieve maize self sufficiency in 2014, the area of production has to be increased to about 4,999,000 ha and the productivity to 5.82 t/ha. The overall policy recommendation based on the dynamic modeling of maize self sufficiency is shown in Figure 7.

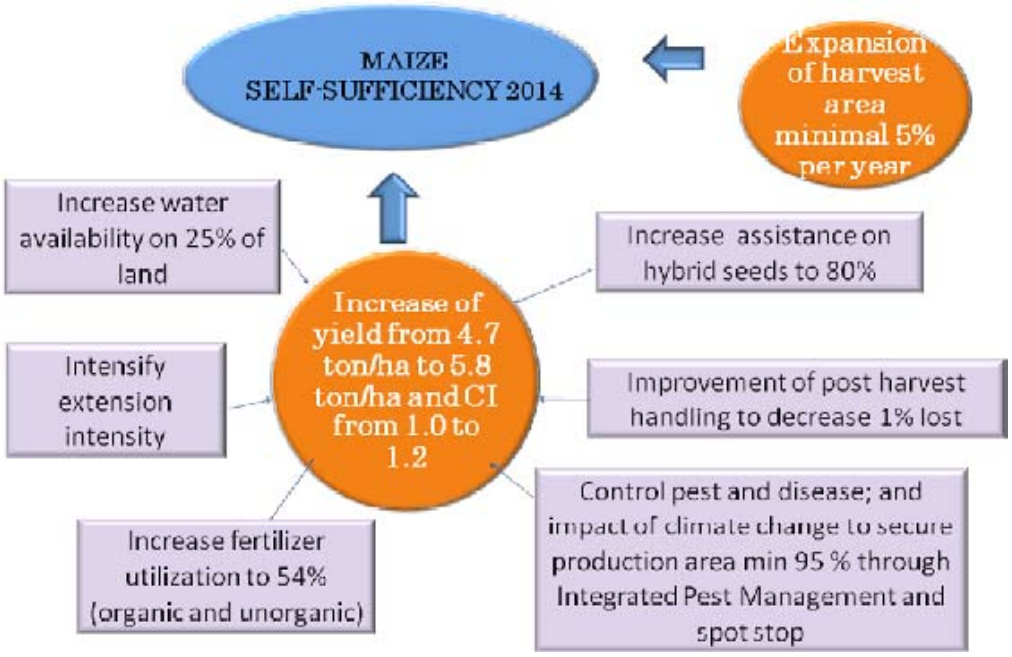

Figure7.with the policy recomendations to achieve maize-sufficiency in 2014.

Research and Development

Indonesian Agency of Agricultural Research and Development (IAARD)has been working on improving varieties, targeted to abiotic stresses (acid soils, low fertility, waterlogging, and drought) and biotic stresses. Since these abiotic stresses are interrelated and play important challenges as maize areas are expanded in the future, research and development for this target environment should be well planned. Similarly biotic stresses on corn, especially downy mildew also need to be put in research priority.

Genetic population improvement through the development of inbred lines, OPVs, and hybrids is a continuous process and must be well programmed. Since the future areaof maize expansion will very much rely on the dryland ecologies of the outer islands, hybrid-oriented breeding programs for low-productivity or stressed environments should be initiated. Maize improvement and agronomy research in Indonesia is now mainly carried out by IAARD. From this insititute, it had been released 46 open pollinated and 26 hybrid maize varieties. However most of the seed of hybrid maize varieties are supplied by the multinational seed companies.

IAARD has worked closely with The International Maize and Wheat Improvement Center (CYMMYT) to search new technologies for enhancement of productivity and profitability of maize in the tropics. Research collaboration between Indonesia and CIMMYT has a long history. The collaboration started since 1981 where some Indonesian researchers had been invited to join research training in CIMMYT headquarter. During the period from 1995 till now, CIMMYT has a measurable impact on maize development in Indonesia, through the collaboration of research activities, germplasm exchanges, and manpower capacity buildings.

Through networking, namely the Tropical Asian Maize Network (TAMNET) and the Asian Maize Network (AMNET) under coordination of CIMMYT, Indonesian Cereal Research Institute (ICERI) has released varieties tolerant to drought stress,such as Bima 2, Bima 4, Bima 5, Bima 15, Bima 16 and Anoman.Other varieties tolerant to soil acidity,such as Bima 7, Bima 8 and Sukmaraga.The Asian Maize Biotechnology Network (AMBIONET), also under the coordination ofCIMMYT, has facilitated ICERI to released downy mildew resistant varieties such as: Bima 3. New verieties tolerant to abiotic stresses will be released, as an output of the networking with the Asian Maize Drought Tolerant and Affordable, AccessibleAsian (AAA), Drought Tolerant Maize Project. We appreciate

CYMMYT for continuingcollaboration in maize development in Indonesia.

Conclusion

- Challenges for anincreasing maize demand, natural resourcedepletion and climate change, will require collaboration between farmers, extension, researchers, policy makers, private sectors, and many other developement agencies.
- To meet the increasing maize demands, production has to be increased, both through the adoption of improved technology and the expansion of planted area.

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